XV. *Observations for ascertaining the length of the Pendulum at Madras in the East Indies, latitude* 13° 4′ 9″,1 *N. with the conclusions drawn from the same. By* JOHN GOLDINGHAM, *Esq. F. R. S.*

Read January 31, 1822.

THE object of the enquiry in this paper has been considered at all times one of interest and importance, and is particularly so at present, when investigations have been completed in Europe, by order of some of the governments there; such as, with reference to their accuracy, had never before been made in any quarter of the globe, so far as comes within my recollection. I had seen the details of Captain KATER's experiments in the Philosophical Transactions, and he also did me the favour to send me out a copy of his Paper. The simplicity and accuracy of the apparatus induced me to write to that Gentleman, requesting he would have the goodness to order a similar one to be sent to me. This request he not only most readily complied with, but made the experiments requisite for enabling me to draw the conclusions; and thence to form the comparison with the results obtained in Europe. The apparatus arrived in March, and I immediately set about fixing it; which, notwithstanding the little solid assistance to be obtained in an operation of this nature from workmen in this country, I was enabled to effect in a most satisfactory manner; and I am led to hope, these observations will not be deemed unworthy the attention of the learned in Europe.

The clock used in these experiments has a gridiron pendulum, the motion being given by a spring; the maker's name is HASWELL, and the works are of the best description: it was fixed to the north wall of the Observatory, which is of solid masonry two feet in thickness: the rate was ascertained by comparisons with the transit clock each day, at the commencement and conclusion of the experiments: the transit of the noon before the comparison, and that after, were used in finding this rate; so that four results were obtained from the two comparisons: the transit clock, which is an excellent time keeper, was regulated by transits of the sun and stars; the weather fortunately having been clear, both at noon and at night, during the time the experiments were making.

The first operation performed was that of making the weight of the clock pendulum black, and fixing the disc on the centre. This having been done, five blocks of seasoned teak-wood, each 4 inches in diameter and 7 in length, were prepared; the place above the clock for the frame, which was to support the pendulum, was then marked. This I did with great care and precaution: intersecting lines were drawn upon the wall to show the exact position of the centres of the blocks and of the screws for fastening the frame; holes 4 inches in diameter and $10\frac{1}{2}$ in depth, (it being necessary to let the outer part of the blocks $3\frac{1}{2}$ inches within the surface of the wall, to bring the pendulum sufficiently near the clock case) were then made in the wall, and the blocks, coated with tar to preserve them from the white ants, were let in and firmly secured. The outer surfaces of the whole, which had previously been made smooth and level, being in

one plane. The frame, its two parts being firmly screwed together, was then placed, levelled by means of a spirit level, and fixed to the blocks in the firmest manner: the frame enclosing the agates was next put up, levelled, and screwed in its place, the Y's elevated, and the pendulum hung; the knife edges were then lowered upon the agates; when I had the satisfaction to find, from the precautions which I had taken, that the pendulum was most correctly in its place. In this distant part of the globe, there is an anxiety in handling and fixing any new apparatus which is not felt in England, where the maker of it is ready to give assistance, as well as to repair any damage that may chance to have been done: here, little or no assistance can be obtained; and if the use of any part of the apparatus should be mistaken, and the part forced into a wrong place, the injury may be fatal to the experiments, as it cannot be repaired here; it therefore affords no small gratification when an instrument is firmly secured, uninjured, in its proper position.

The pendulum is precisely the same, in all its parts, as that used by Captain KATER at the different stations of the Trigonometrical Survey of England, and which he has fully described in the Philosophical Transactions for 1819. Any farther description therefore of its construction, will here be unnecessary.

The next operation was to fix the arc for measuring the vibrations. The clock-case was of handsome mahogany enriched with projecting mouldings, with the door in front of plate glass. The mouldings kept the pendulum at too great a distance from the part of the case where the arc could otherwise have been fastened, and it became necessary to

have a support in front of the case. I therefore had a solid stand of teak wood made, similar to that for supporting the telescope, the inner part cut out to the form of the mouldings of the clock-case, so that it fitted perfectly close to it; in this position it was screwed to the floor; the ends for the supports of the arc were then let in, and secured to the top of the stand, and the arc fixed in its proper place, with reference to the extreme point of the pendulum. The floor outside of this apparatus was then separated from the part of the floor which supported it, to prevent any shake by persons moving about within the building.

The small telescope containing the diaphragm was now fixed upon its stand, and screwed to the floor at the proper distance from the pendulum: this was about $9\frac{1}{2}$ feet. The telescope, and every other part of the apparatus, have been so fully described by Captain KATER in the paper published in the Philosophical Transactions, that I feel it unnecessary to be more particular here.*

While making the holes in the wall above the clock for the insertion of the blocks for supporting the frame, a great deal of dust would necessarily fall upon the clock-case; every part of the case where dust could penetrate was therefore filled up with wax, and several folds of cloth were afterwards secured over the whole of the case, so that it was hardly possible that any dust could penetrate to the works of the clock. After the frame was fixed, the cloth and wax were removed, and fresh oil applied to the works.

* The drawing [Pl. XIV] shows the inside of a part of the Observatory, the pendulum up, and the adjustment of the diaphragm making, preparatory to commencing the observations.

The clock was then set in motion. This was on the 22d of March, and the observations commenced two days afterwards.

The following is the mode pursued in making the observations.

The pendulum was lifted up from the Y's by myself and an assistant, and the knife edges wiped with a cloth saturated with oil. The pendulum was then replaced, and the Y's lowered, so that the knife edges rested upon the agates. The telescope was then adjusted (care being taken that the O on the arc of vibration coincided with the point of the slip), so that the edges of the slip were exactly embraced by the edges of the diaphragm. The height of the barometer, of the thermometer fixed near the middle of the pendulum, and that of the hygrometer, were taken and registered. The point of the slip at the end of the pendulum was then brought and kept by the hand to about 1°,3 upon the arc; and an instant before the pendulum of the clock was at its highest point on the same side, the hand was withdrawn, and the pendulum thereby allowed to vibrate freely. I stationed the head Bramin assistant* to take down the time, and the youngest Bramin assistant to count the clock, which he does with the greatest correctness. Having placed myself at the telescope, I found there was a sensible portion of time, more or less, as the arc of vibration was greater or smaller, between the disappearance of the disc behind the slip, and its reappearance; I therefore noticed the seconds, and parts of a second, when the disc disappeared, and also the instant when it

* The name of the head assistant is Senavassaehary, and that of the other Teroovencatachary.

again appeared, both which the Bramin put down; the mean of these I took as the true time of the coincidence, and registered it accordingly. These times I found could be accurately noted; and it is probable the mean of the two observations is generally correct to less than half a second. In this manner the times of the coincidences were observed. The thermometer often varying a good deal in a short time, I thought it right to take its height three times, at the third observation of each set, as well as the first and fifth. The barometer was observed at the end of each set, as well as at the beginning; and also the hygrometer, as mentioned above, at the beginning of the observations, and likewise at the end of those of each day; being desirous of seeing how much the atmosphere had changed in dryness, as well as in heat and weight; not that this was material, but it is satisfactory to know what change there actually was in the atmosphere during the time the observations were making. I now proceed to detail the observations.

Every observation taken is here given. As although in this as in similar cases, one feels better pleased with some observations than with others, yet I do not recollect more than two of these observations, which I felt dissatisfied with at the time, and that not in a sufficient degree to induce me to think of rejecting them.

The results, I trust, will prove how unnecessary it would have been to have rejected any of the observations.

OBSERVATIONS.

FIRST SERIES.

h.	m.	Inch.
6	24	30,085
7	12	30,101

March 24th A. M.

Rate of the Clock —0″,39.
Hygrometer 11°,5 dry.

Mean - 30,093

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
°	h. m. s.	°	°	″			+	+	
81	6 23 44	1,15							
			1, 10	721,25	719,25	86160,42	1,983	4,687	86167,090
	35 45,25	1,05							
			1, 01	722,75	720,75	86160,91	1,671	4,750	86167,331
81,3	47 48	0,97							
			0,935	724	722	86161,33	1,432	4,793	86167,555
	59 52	0,88							
			0,835	723, 8	721, 8	86161,26	1,102	4,814	86167,216
81,4	7 11 55,8	0,79							
81,23	Mean						Rate of the Clock		86167,298 — 0,390
									86166,908

Rate of the Clock —0″,39

Barometer { 30,105 / 30,123

Mean - 30,114

	h. m. s.	°	°	″			+	+	
81,5	7 24 50,5	1,13							
			1,065	722, 4	720, 4	86160,80	1,858	4,809	86167,467
	36 52,9	1,00							
			0, 95	725, 7	723, 7	86161,88	1,479	4,915	86168,274
82	48 58,6	0,90							
			0, 87	723,65	721,65	86161,21	1,240	5,152	86167,602
	8 1 2,25	0,84							
			0,795	723,75	721,75	86161,24	1,036	5,300	86167,576
82,7	13 6,0	0,75							
81,73	Mean						Rate of the Clock		86167,729 —,390
									86167,339

Barometer { 30,137 / 30,134

Mean - 30,135

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
°	h. m. s.	°	°	"			+	+	
82,9	8 29 26,5	1,15							
			1,10	720, 6	718, 6	86160,20	1,983	5,512	86167,692
	41 27,1	1,05							
			1,00	725, 0	723, 0	86161,66	1,638	5,592	86168,888
83,4	53 32,1	0,95							
			0,91	722,65	720,65	86160,88	1,357	5,765	86167,995
	9 5 34,75	0,87							
			0,83	722,65	720,65	86160,88	1,129	5,956	86167,996
84,3	17 37,4	0,79							
83,53	Mean						Rate of the Clock		86168,135 — 0,390
									86167,745

Barometer { 30,129 / 30,140

Mean - 30,135

	h. m. s.	°	°	"			+	+	
84,5	9 33 39,25	1,11							
			1, 07	719,35	717,35	86159,78	1,876	6,188	86167,844
	45 38,6	1,03							
			0, 99	718,15	716,15	86159,38	1,605	6,290	86167,275
85	57 36,75	0,95							
			0,915	718,75	716,75	86159,58	1,372	6,345	86167,297
	10 9 35,5	0,88							
			0, 84	719, 5	717, 5	86159,83	1,156	6,345	86167,331
85	21 35,0	0,80							
84,83	Mean						Rate of the Clock		86167,437 — ,390
									86167,047

Hygrometer 13, dry — Barometer { 30,140 / 30,143 }

Mean - 30,141

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
°	h. m. s.	°	°	"			+	+	
84,9	10 30 16,6	1,20							
			1,165	713,65	711,65	86157,86	2,224	6,315	86166,399
	42 10,25	1,13							
			1,085	715,25	713,25	86158,01	1,929	6,332	86166,654
85	54 5,5	1,04							
			1,015	717,0	715, 0	86159,00	1,688	6,345	86167,033
	11 6 2,5	0,99							
			0,945	715,65	713,65	86158,64	1,463	6,345	86166,348
85	17 58,15	0,90							
84,97	Mean					Rate of the Clock			86166,608 — ,390
									86166,218

March 25, A. M. — Barometer { 30,143 / 30,147 }

Clock losing 1",49 / Hygrometer 12°. dry — Mean - 30,145

°	h. m. s.	°	°	"			+	+	
80,3	6 14 0,25	1,24							
			1,205	717,5	715, 5	86159,16	2,379	4,433	86165,972
	25 57,75	1,17							
			1,130	720,25	718,25	86160,08	2,092	4,581	86166,753
81,0	37 58	1,09							
			1,055	720,5	718, 5	86160,03	1,826	4,674	86166,530
	49 58,5	1,02							
			0,980	722,6	720, 6	86160,86	1,574	4,716	86167,150
81,2	7 2 1,1	0,94							
80,83	Mean					Rate of the Clock			86166,601 — 1,490
									86165,111

End of the Experiments. Barometer { 30,147 / 30,161

Hygrometer $12°\frac{1}{8}$ dry. Mean - 30,154

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
81,2	7 10 19,5	1,28							
			1, 23	719,1	717,1	86159,70	2,479	4,780	86166,959
	22 18,6	1,18							
			1,125	722	720	86160,66	2,073	4,864	86167,597
81,6	34 20,6	1,07							
			1, 02	723	721	86160,99	1,705	4,949	86167,644
	46 23,6	0,97							
			0, 91	724,5	722,5	86161,49	1,357	5,245	86168,092
82	58 28,1	0,85							
81,6	Mean						Rate of the Clock		86167,573 — 1,490
									86166,083

March 26, P. M. Barometer { 30,132 / 30,133

Clock losing 1",91 } Hygrometer 15°,6 dry } Mean - 30,133

	h. m. s.	°	°	"			+	+	
84	4 58 37,1	1,20							
			1,15	716, 5	714, 5	86158,83	2,167	5,913	86166,910
	10 33,6	1,10							
			1,07	717,85	715,85	86159,28	1,876	5,888	86167,044
83,9	22 31,45	1,04							
			1,01	719,05	717,05	86159,68	1,671	5,837	86167,188
	34 30,5	0,98							
			0,94	720,	718, 0	86160,00	1,448	5,753	86167,201
83,5	46 30,5	0,90							
83,8	Mean						Rate of the Clock		86167,086 — 1,910
									86165,176

March 26, A. M.

Clock losing 2″,08
Hygrometer 14°, dry.

Barometer { 30,149 / 30,150
Mean - 30,149

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
79,3	5 58 58,1	1,19							
			1, 14	723,27	721,27	86161,08	2,129	3,955	86167,164
	11 1,37	1,09							
			1,045	725,38	723,38	86161,70	1,789	3,997	86167,466
79,5	23 6,75	1,00							
			0,965	725, 5	723, 5	86161,81	1,526	4,048	86167,384
	35 12,25	0,93							
			0, 90	727, 2	725, 2	86162,37	1,327	4,116	86167,813
79,8	47 19,45	0,87							
79,53	Mean						Rate of the Clock		86167,457 — 2,080
									86165,377

Hygrometer 13°,6 dry.

Barometer { 30,150 / 30,173
Mean - 30,162

	h. m. s.	°	°	″			+	+	
79,8	6 56 30,62	1,29							
			1, 24	721,88	719,88	86161,63	2,519	4,264	86168,413
	7 8 32,5	1,19							
			1, 14	724, 0	722, 0	86161,32	2,129	4,496	86167,945
80,9	20 36,5	1,09							
			1,045	724,17	722,17	86161,38	1,789	4,653	86167,822
	32 40,67	1,00							
			0,965	725,33	723,33	86161,76	1,526	4,738	86168,024
81,3	44 46,	0,93							
80,67	Mean						Rate of the Clock		86168,031 — 2, 08
									86165,971

March 27, P. M.

Clock losing 2″,06
Hygrometer 20° dry.

Barometer { 30,116
30,131
Mean - 30,123

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
84, 7	4 13 44,25	1,24							
			1, 20	715,87	713,87	86158,62	2,359	6,176	86167,155
	25 40,12	1,16							
			1, 12	716,51	714,51	86158,83	2,055	6,091	86166,976
84, 3	37 36,63	1,08							
			1,035	717,87	715,87	86159,29	1,755	6,028	86167,070
	49 34, 5	0,99							
			0,955	717,87	715,87	86159,28	1,494	5,985	86166,759
84, 1	5 1 32,37	0,92							
84,37	Mean					Mean of the Clock			86166,990 — 2,060
									86164,930

Hygrometer 19°,3 dry.

Barometer { 30,131
30,087
Mean - 30,109

	h. m. s.	°	°	″			+	+	
84,1	5 10 14,75	1,28							
			1,235	716,50	714,50	86158,83	2,499	5,943	86167,272
	22 11,25	1,19							
			1, 14	718,50	716,50	86159,50	2,129	5,901	86167,530
83,9	34 9,75	1,09							
			1,045	718,87	716,87	86159,62	1,789	5,837	86167,246
	46 8,62	1,00							
			0, 96	720,63	718,63	86160,21	1, 51	5,753	86167,473
83,5	58 9,25	0,92							
83,83	Mean					Rate of the Clock			86167,380 — 2,060
									86165,320

March 29, P. M.

Clock losing 1″,46
Hygrometer 17°,7 dry.

Barometer { 30,084 / 30,113

Mean - 30,098

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations. in 24 hours.
	h. m. s.	°	°	″			+	+	
84,5	2 59 8	1,23							
			1,19	719,12	717,12	86159,71	2,320	6,112	86168,142
	3 11 7,12	1,15							
			1,11	720,88	718,88	86160,29	2,019	6,070	86168,389
84,3	23 8,0	1,07							
			1,02	723, 0	721, 0	86160,99	1,705	6,028	86168,723
	35 11,0	0,97							
			0,93	723,63	721,63	86161,20	1,417	5,985	86168,602
84,1	47 14,63	0,89							
84,3	Mean					Rate of the Clock			86168,464 — 1,460
									86167,004

Hygrometer 17°,7 dry.

Barometer { 30,113 / 30,087

Mean - 30,100

	h. m. s.	°	°	″			+	+	
84,1	3 56 44,75	1,26							
			1,215	721, 0	719, 0	86160,33	2,418	5,956	86168,704
	48 45,75	1,17							
			1,115	721,75	719,75	86160,58	2,037	5,930	86168,447
84	20 47,50	1,06							
			1,015	723,62	721,62	86161,20	1,688	5,922	86168,810
	32 51,12	0,97							
			0, 93	723,13	721,13	86161,04	1,417	5,922	86168,379
84	44 54,25	0,89							
84,03	Mean					Rate of the Clock			86168,585 — 1, 46
									86167,121

March 30, P. M.

Clock losing 1″,96
Hygrometer 16°,2 dry.

Barometer { 30,136 / 30,117
Mean - 30,126

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibration in 24 hours.
	h. m. s.	°	°	″			+	+	
84,4	2 57 1, 5	1,27							
			1,225	721, 0	719, 0	86160,33	2,459	6,083	86168,872
	3 9 2, 5	1,18							
			1,135	721,25	719,25	86160,42	2,111	6,057	86168,588
84,3	21 3,75	1,09							
			1,045	722, 5	720, 5	86160,83	1,789	6,049	86168,668
	33 6,25	1,00							
			0, 96	723,37	721,37	86161,12	1,510	6,049	86168,679
84,3	45 9,62	0,92							
84,33	Mean					Rate of the Clock			86168,702 — 1,960 = 86166,742

Hygrometer 16°,5 dry.

Barometer { 30,117 / 30,115
Mean - 30,116

	h. m. s.	°	°	″			+	+	
84,3	3 52 18,25	1,24							
			1, 19	720,62	718,62	86160,21	2,320	6,028	86168,558
	4 4 18,87	1,14							
			1,095	722,13	720,13	86160,71	1,965	5,985	86168,660
84,1	16 21	1,05							
			1,005	723,75	721,75	86161,24	1,655	6,008	86168,903
	28 24,75	1,96							
			0,925	723,63	721,63	86161,20	1,402	5,977	86 68,579
84	40 38,28	0,89							
84,13	Mean					Rate of the Clock			86168,675 — 1,960 = 86166,715

March 30, A. M.

Barometer { 30,124 / 30,144

Clock losing 2″,23
Hygrometer 13°,7 dry.

Mean - 30,134

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	′			+	+	
80,1	6 0 30	1,29							
			1,245	720, 5	718, 5	86160,17	2,539	4,327	86167,036
	12 30,5	1,20							
			1, 16	721,25	719,25	86160,41	2,205	4,433	86167,048
80,6	24 31,75	1,12							
			1, 08	721,87	719,87	86160,62	1,911	4,518	86167,049
	36 33,62	1,04							
			1, 0	723,50	721,50	86161,16	1,639	4,577	86167,376
80,9	48 37,12	0,96							
80,53	Mean					Rate of the Clock			86167,127
									— 2, 23
									86164,897

Hygrometer 13°,3 dry.

Barometer { 30,144 / 30,162

Mean - 30,153

	h. m. s.	°	°	″			+	+	
81	6 59 7,12	1,19							
			1,145	722,75	720,75	86160,91	2,148	4,695	86167,753
	7 11 9,87	1,10							
			1, 05	723,63	721,63	86161,20	1,806	4,780	86167,786
81,4	23 13, 5	1, 0							
			0,965	724, 0	722, 0	86161,33	1,526	4,843	86167,699
	35 17, 5	0,93							
			0,905	724, 5	722, 5	86161,49	1,341	4,886	86167,717
81,6	47 22, 0	0,88							
81,33	Mean					Rate of the Clock			86167,739
									— 2,230
									86165,509

March 31, P. M.

Clock losing 2″,24
Hygrometer 16°,2 dry.

Barometer { 30,07 / 30,066

Mean - 30,068

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
85,1	3 8 27,5	1,24							
			1, 19	718,25	716,25	86159,42	2,320	6,366	86168,106
	20 25,75	1,14							
			1,095	719,37	717,37	86159,78	1,965	6,324	86168,069
84,9	32 25,12	1,05							
			1,005	720,38	718,38	86160,13	1,656	6,273	86168,059
	44 25, 5	0,96							
			0,940	719,75	717,75	86159,92	1,448	6,210	86167,578
84,6	56 25,25	0,88							
84,87	Mean						Rate of the Clock		86167,953 — 2,240
									86165,713

Hygrometer 16°,3 dry.

Barometer { 30,066 / 30,061

Mean - 30,064

	h. m. s.	°	°	″			+	+	
84,6	4 6 55, 5	1,37							
			1,32	716,62	714,62	86158,87	2,855	6,155	86167,880
	18 52,12	1,27							
			1,22	717,75	715,75	86159,24	2,439	6,112	86167, 79
84,4	30 49,87	1,17							
			1,12	720,00	718,00	86160,00	2,055	6,074	86168,129
	42 49,87	1,07							
			1,02	719,75	717,75	86159,67	1,705	6,049	86167,424
84,26	54 49,62	0,97							
84,42	Mean						Rate of the Clock		86167,806 — 2,240
									86165,566

March 31, P. M.

Clock losing 2″10
Hygrometer 14°,6 dry.

Barometer { 30,098 / 30,114
Mean - 30,106

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc-	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
81,3	5 59 27, 5	1,21							
			1, 17	721, 5	719, 5	86160,50	2,243	4,763	86167,506
	6 11 28, 5	1,13							
			1,095	723,12	721,12	86161,03	1,964	4,733	86167,727
81,15	23 31,62	1,06							
			1,025	723,88	721,88	86161,29	1,721	4,725	86167,736
	35 35, 5	0,99							
			0,955	724,87	722,87	86161,61	1,494	4,750	86167,854
81,25	47 40,37	0,92							
81,23	Mean						Rate of the Clock		86167,706 — 2,100
									86165,606

Hygrometer 13°,5 dry.

Barometer { 30,114 / 30,130
Mean - 30,122

	h. m. s.	°	°	″			+	+	
81,35	6 59 59, 5	1,20							
			1, 16	722,75	720,75	86160,91	2,205	4,822	86167,937
	12 2,25	1,12							
			1, 08	724,37	722,37	86161,45	1,911	4,864	86168,225
81,55	24 6,62	1,04							
			0,995	725,75	723,75	86161,90	1,622	4,941	86168,463
	36 12,37	0,95							
			0, 91	726,63	724,63	86162,19	1,357	5,021	86168,568
81,95	48 19,00	0,87							
81,62	Mean						Rate of the Clock		86168,298 — 2,100
									86166,198

April 1, P. M.

Clock losing 1″85
Hygrometer 16°8 dry.

Barometer { 30,100 / 30,087
Mean - 30,094

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
85,3	2 23 30,62	1, 18							
			1,137	717,52	715,52	86159,17	2,118	6,473	86167,761
	35 28,12	1,095							
			1,048	720,13	718,13	86160,04	1,799	6,473	86168,312
85,3	47 28,25	1,000							
			0, 96	720,75	718,75	86160,25	1,510	6,455	86168,215
	59 29	0, 92							
			0,883	721, 5	719, 5	86160,50	1,278	6,425	86168,203
85,15	3 11 30, 5	0,845							
85,25	Mean					Rate of the Clock			86168,123 — 1,850 = 86166,273

Hygrometer 16°,8 dry.

Barometer { 30,087 / 30,083
Mean - 30,085

	h. m. s.	°	°	″			+	+	
85,15	3 19 39,75	1,27							
			1,21	719,25	717,25	86159,75	2,399	6,404	86168,553
	31 39	1,15							
			1,10	719,62	717,62	86159,87	1,983	6,396	86168,249
85,10	43 38,62	1,05							
			1,01	720,63	718,63	86160,21	1,671	6,383	86168,264
	55 39,25	0,97							
			0,93	722,00	720,00	86160,66	1,417	6,375	86168,452
85,06	4 7 41,25	0,89							
85,10	Mean					Rate of the Clock			86168,379 — 1,850 = 86166,529

April 1, P. M.

Clock losing 1″,86
Hygrometer 48° dry.

Barometer { 30,126 / 30,134
Mean - 30,130

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Contraction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
81,95	6 16 49,75	1, 19							
			1,145	722,25	720,25	86160,83	2,148	5,114	86168,092
	28 52,0	1, 10							
			1,055	723,13	721,13	86161,04	1,824	5,233	86168,097
82,5	40 55,13	1, 01							
			0,978	723,37	721,37	86161,12	1,567	5,300	86167,987
	52 58,5	0,945							
			0,912	723,62	721,62	86161,20	1,363	5,321	86167,884
82,6	7 5 2,12	0, 88							
82,35	Mean						Rate of the Clock		86168,015 — 1,860
									86166,155

Hygrometer 13°,8 dry.

Barometer { 30,134 / 30,172
Mean - 30,153

	h. m. s.	°	°	″			+	+	
82,6	7 13 12,62	1,195							
			1,148	722	720	86161,00	2,159	5,355	86168,514
	25 14,62	1, 10							
			1, 06	723,88	721,88	86161,28	1,841	5,410	86168,531
82,85	37 18,5	1, 02							
			0, 98	725,12	723,12	86161,69	1,574	5,444	86868,708
	49 23,62	0, 94							
			0, 89	725,63	723,63	86161,86	1,321	5,469	86168,650
82,95	8 1 29,25	0,855							
82,80	Mean						Rate of the Clock		86168,601 — 1,860
									86166,741

April 2, P. M.

Clock losing 2″09
Hygrometer 16°,7 dry.

Barometer { 30,135 / 30,127
Mean - 30,131

Tem.	Time of coincideuce.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
85,75	2 52 1,5	1, 23							
			1, 18	719,62	717,62	86159,87	2,281	6,620	86168,771
	3 4 1,12	1, 13							
			1,085	719,88	717,88	86159,96	1,929	6,535	86168,424
85,35	16 1,0	1, 04							
			0,993	721, 0	719, 0	86160,33	1,616	6,455	86168,401
	28 2	0,945							
			0, 91	720,12	718,12	86160,04	1,357	6,383	86167,780
85,0	40 2,12	0,875							
85,37	Mean					Rate of the Clock			86168,344 — 2,090 = 86166,254

Hygrometer 16°7 dry.

Barometer { 30,127 / 30,118
Mean - 30,123

	h. m. s.		°	″			+	+	
85	3 46 27,87	1,195							
			1,153	719,88	717,88	86159,96	2,178	6,324	86168,462
	58 27,75	1,110							
			1,052	720,25	718,25	86160,08	1,813	6,282	86168,175
84,8	4 10 28,0	0,995							
			0,958	722,12	720,12	86160,70	1,504	6,260	86168,464
	22 30,12	0, 92							
			0,885	722,03	720,03	86160,68	1,283	6,260	86168,223
84,8	34 32,15	0, 85							
84,87	Mean					Rate of the Clock			86168,331 — 2,090 = 86166,241

The correction for the arc of vibration was ascertained by multiplying the square of the mean arc by 1,6385. The correction for temperature was found as follows: the mean of the thermometer at the beginning and middle of the observations was taken, and that of the middle and end; which gave five heights, one for each observation; the mean of the first and second, of the second and third, and so on in succession was taken, which gave four mean heights; the difference between each of these and 70° was multiplied by 0,423, the part of a vibration due to each degree of the thermometer, as furnished by Captain KATER, and the required correction was obtained.

The rate of the clock was found as before mentioned. The following shows the daily rate of the transit clock, in the interval during which the observations were taken; and furnishes a satisfactory example of the good performance of this standard for finding the rate of the other clock.

Rate of the Transit Clock.

March	22	- -	— 0,25	March	29	- -	+ 0,09
	23	- -	+ 0,13		30	- -	+ 0,05
	24	- -	— 0,05		31	- -	— 0,03
	25	- -	+ 0,23	April	1	- -	+ 0,02
	26	- -	+ 0,10		2	- -	— 0,08
	27	- -	+ 0,15		3	- -	+ 0,05
	28	- -	+ 0,20		4	- -	— 0,04

Table of the Results of the foregoing Experiments.

Day. 1821.	Time of the Experiment.	Mean Height of the Thermometer.	Mean Height of the Barometer.	Mean Height of the Hygrometer.	Number of Vibrations in 24 hours, at the temperature of 70° of Farenheit.
		°	Inch.	dry.	
March 24	A. M.	81,23	30,093		86166,908
		81,73	30,114		86167,339
		83,53	30,135		86166,275
		84,83	30,135	12,25	86167,047
		84,97	30,141		86166,218
25	A. M.	80,83	30,145		86165,111
		81, 6	30,154	12,22	86166,083
26	P. M.	83, 8	30,133		86165,176
	A. M.	79,53	30,149	14, 4	86165,377
		80,67	30,162		86165,971
27	P. M.	84,37	30,123		86164,930
		83,83	30,109	19, 6	86165,320
29	P. M.	84, 3	30,098		86167,004
		84,03	30,100	17, 7	86167,121
30	P. M.	84,33	30,126		86166,742
		84,13	30,116		86166,715
	A. M.	80,53	30,134	14,92	86164,897
		81,33	30,153		86165,509
31	P. M.	84,87	30,068		86165,713
		84,42	30,064	15,15	86165,566
	A. M.	81,23	30,106		86165,606
		81,62	30,122		86166,198
April 1	P. M.	85,25	30,094		86166,273
		85,10	30,085		86166,529
	A. M.	82,35	30,130	15,65	86166,155
		82,80	30,153		86166,741
2	P. M.	85,37	30,131		86166,254
		84,87	30,123	16, 7	86166,241
Mean		83,48	30,121	15,38	86166,108

Second Series of Experiments for ascertaining the length of the Pendulum at Madras.

Thinking it possible that these Observations might be referred to by future observers in other parts of the world, and wishing to have as accurate results as I could obtain, I deter-

mined to take a second series; having made what I considered some improvement in detaching the clock and apparatus from the floor of the building. In this series, besides comparisons for the rate of the clock used in the experiments, with the transit clock at the time of making the experiments, transits of stars were taken with this clock for the purpose. The result of this series, however, seems to prove, that every necessary precaution had been used in the first, the difference of the two being only 0,06 of a vibration in 24 hours.*

The following are the Observations of the Second Series.

OBSERVATIONS.

SECOND SERIES.

April 18th A. M.

Rate of Clock + 0″,97
Hygrometer 12°,6 dry.

Barometer { 30,018 / 30,029
Mean - 30,025

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For temperature.	Vibrations. in 24 hours.
	h. m. s	°	°	″			+	+	
82,7	18 14 21,75	1,275							
			1,122	711,12	709,12	86157,00	2,447	5,402	86164,849
	26 12,87	1, 17							
			1,125	712,63	710,63	86157,52	2,074	5,469	86165,063
83	38 5,50	1, 08							
			1,035	713, 0	711, 0	86157,64	1,755	5,550	86164,945
	49 58,50	0, 99							
			0,953	713,62	711,62	86157,86	1,488	5,643	86164,691
83,45	19 1 52,12	0,915							
83,05	Mean						Rate of the Clock		86164,887
									+ 0,970
									86165,857

* By rejecting the 4 in each series, which differs most from the mean, we obtain a mean 0,03 of a vibration less than that from which the conclusions have been drawn.

Barometer { 30,029 / 30,044

Mean - 30,037

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
83,45	19 11 27,12	1, 30							
			1, 25	708,63	706,63	86156,15	2,560	5,748	86164,478
	23 15,75	1, 20							
			1,155	711,38	709,38	86157,09	2,186	5,863	86165,539
84,0	35 7,13	1, 11							
			1,067	711,12	709,12	86157,00	1,865	5,985	86164,850
	46 58,25	1,025							
			0,990	712,12	710,12	86157,34	1,606	6,112	86165,058
84,6	58 50,37	0,955							
84,02	Mean						Rate of the Clock		86164,981 + ,970
									86165,951

Hygrometer 15° dry.

Barometer { 30,044 / 30,045

Mean - 30,044

	h. m. s.	°	°	"			+	+	
84,6	20 13 1, 5	1, 39							
			1,337	709, 0	707, 0	86156,28	2,929	6,218	86165,424
	24 50, 5	1,285							
			1,233	708,75	706,75	86156,19	2,491	6,303	86164,984
85	36 39,25	1, 18							
			1,132	710, 0	708	86156,66	2,100	6,396	86165,156
	48 29,25	1,085							
			1,043	709,37	707,37	86156,40	1,782	6,502	86164,684
85,5	21 0 18,62	1, 00							
85,04	Mean						Rate of the Clock		86165,062 + ,970
									86166,032

April 19, P. M.

Rate of Clock 0″88
Hygrometer 16°5 dry.

Barometer { 29,983 / 29,961

Mean - 29,972

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
87,5	2 21 17,62	1,275							
			1.223	707,50	705,50	86155,76	2,451	7,386	86165,597
	33 5,12	1,170							
			1,112	708,50	706,50	86156,01	2,026	7,356	86165,392
87,35	44 53,62	1,055							
			1,015	710,88	708,88	86157,06	1,688	7,318	86166,066
	56 44, 5	0,975							
			0,933	709,62	707,62	86156,49	1,426	7,276	86165,192
87,15	3 8 34,12	0,890							
87,33	Mean						Rate of the Clock		86165,562 + ,880
									86166,442

Barometer { 29,961 / 29,952

Mean - 29,956

	h. m. s.	°	°	″			+	+	
87,1	3 17 0,12	1, 26							
			1, 20	708,50	706,50	86156,01	2,359	7,212	86165,461
	28 48,62	1, 14							
			1,093	707,88	705,88	86155,89	1,958	7,170	86165,018
86,9	40 36, 5	1,045							
			1,013	710,62	708,62	86156,83	1,681	7,136	86165,647
	52 27,12	0, 98							
			0,935	710,50	708,50	86156,79	1,432	7,115	86165,337
86,8	4 4 17,62	0, 89							
86,93	Mean						Rate of the Clock		86165,366 + ,880
									86166,246

Hygrometer 16°5 dry. Barometer { 29,952 / 29,948

Mean - 29,950

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Contraction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
86,8	4 11 57,4	1,19							
			1, 14	709,22	707,22	86156,35	2,129	7,064	86165,543
	23 46,62	1,09							
			1,045	710, 0	708, 0	86156,62	1,789	6,679	86165,388
86,4	35 36,62	1,00							
			0,955	711,75	709,75	86157,22	1,491	6,908	86165,619
	47 28,37	0,91							
			0,865	712,25	710,25	86157,39	1,226	6,840	86165,456
86,1	59 20,62	0,82							
86,43	Mean						Rate of the Clock		86165,572 + ,880
									86166,382

April 19, A. M. 18h 20 Civil. Barometer { 30,046 / 30,041

Rate of Clock + 0"70
Hygrometer 13°4 dry. } Mean - 30,044

	h. m. s.	°	°	"			+	+	
83	17 54 47,62	1, 29							
			1,243	710,25	708,25	86156,705	2,532	5,562	86164,799
	18 6 37,87	1,195							
			1,150	711,50	709, 5	86157,132	2,167	5,689	86164,988
83,6	18 29,37	1,105							
			1,067	711,50	709,50	86157,132	1,865	5,753	86164,750
	30 20,87	1,030							
			0,995	713,63	711,63	86157,843	1,622	5,753	86165,218
83,4	Mean						Rate of the Clock		86164,939 +0,700
									86165,639

Barometer { 30,041
30,050

Mean - 30,045

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	//			+	+	
83,6	18 49 21	1,305							
			1,257	709,75	707,75	86156,533	2,589	5,795	86164,917
	19 1 10,75	1, 21							
			1, 16	712,37	710,37	86157,429	2,205	5,880	86165,514
84	13 3,12	1, 11							
			1, 07	711,38	709,38	86157,091	1,876	5,951	86164,918
	24 54, 5	1, 03							
			1, 00	713, 5	711, 5	86157,813	1,638	6,002	86165,453
84,25	36 48	0, 97							
83,95	Mean						Rate of the Clock		86165,200 + ,700
									86165,900

Hygrometer 13°,6.

Barometer { 30,050
30,036

Mean - 30,043

	h. m. s.	°	°	//			+	+	
84,25	19 44 11, 5	1, 25							
			1, 21	710,25	708,25	86156,705	2,399	6,104	86165,208
	56 1,75	1, 17							
			1,125	711,37	709,37	86157,088	2,074	6,252	86165,414
84,95	20 7 53,12	1, 08							
			1,038	711,50	709,50	86157,132	1,765	6,341	86165,238
	19 44,62	0,995							
			0,958	712,13	710,13	86157,347	1,504	6,370	86165,221
85,1	31 36,75	0,920							
84,77	Mean						Rate of the Clock		86165,270 + ,700
									86165,700

occasions the final equations, by using a formula for the computation of V, different from that given by M. LAPLACE.

Previously to the computation, I re-calculated the observations of April 8, 11, 14, 21, and May 3, using the places of the stars as given by M. PIAZZI. This perhaps was unnecessary.

The results were

	Æ	Declination S.
	h. m. s.	° ′ ″
April 8	2 34 15,0	7 51 52
11	2 46 28,0	7 12 4
14	2 57 14,2	6 33 51
21	3 17 46,1	5 13 35
May 3	3 44 19,7	3 25 55

By M. LAPLACE's method, "Determination approchée, &c." the observations of April 8, 11, and 14, give perihelion dist. $(p) = ,0865$, and time of perihelion, March $19^d\ 14^h\ 4^m$.

Let the true perihelion dist. $= p + dp$, and time of perihelion $=$ March $19^d\ 14^h\ 4^m - dt$, so that t being the interval between March $19^d\ 14^h\ 4^m$, and the observation of April 8, the true value of $t = t + dt$.

Let also T $=$ the time in the table of the comet of 109 days, when the anomaly $= v$.

$\Delta =$ variation of anomaly in that table in one day at time T, and $r =$ comet's distance from the sun

$$\text{Then } dv = \left(\frac{dt}{p^{\frac{3}{2}}} - \frac{3tdp}{p^{\frac{5}{2}}}\right)\Delta \quad - \quad - \quad (1)$$

$$\text{and } (x)\ \frac{d \log r}{\sin 1''} = dv \tan \tfrac{1}{2} v + \frac{dp}{p \sin 1''} \quad (2)$$

Conceive the triangle in which S, T, C, represent the sun, earth, and comet respectively, and let P represent the projection of the comet on the plane of the earth's orbit.

Hygrometer 17°,5 dry. Barometer {30,030 / 30,032}

Mean - 30,031

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
86, 9	4 2 37,87	1,19							
			1,145	709,75	707,75	86156,533	2,148	7,140	86165,821
	14 27,62	1,10							
			1, 05	710,88	708,88	86157,061	1,806	7,115	86165,982
86, 8	26 18, 5	1, 0							
			0,955	711,37	709,37	86157,088	1,491	7,085	86165,664
	38 9,87	0,91							
			0,875	712,50	710,50	86157,473	1,255	7,043	86165,771
86, 6	50 2,37	0,84							
86,73	Mean						Rate of the Clock		86165,809 + ,370
									86166,179

April 21, A. M.

Rate of Clock 0",63

Hygrometer 14° dry.

Barometer {30,064 / 30,062}

Mean - 30,063

	h. m. s.	°	°	"			+	+	
83,4	17 51 37	1,305							
			1,255	708,62	706,62	86156,489	2,581	5,681	86164,751
	18 3 25,62	1,205							
			1,159	710,13	708,13	86156,664	2,201	5,702	86164,567
83,5	15 15,75	1,114							
			1,082	711,00	709,00	86156,692	1,918	5,732	86164,342
	27 6,75	1,060							
			1,023	712,12	710,12	86157,344	1,715	5,773	86164,832
83,7	38 58,87	0,985							
83,53	Mean						Rate of the Clock		86164,623 + ,630
									86165,253

Barometer $\left\{\begin{matrix}30,062\\30,068\end{matrix}\right.$

Mean - 30,065

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations. in 24 hours.
	h. m. s.	°	°	"			+	+	
83,7	18 45 38, 5	1,205							
			1,157	709,87	707,87	86156,575	2,193	5,808	86164,576
	57 28,37	1,110							
			1,083	711,26	709,26	86157,050	1,922	5,829	86164,801
83,8	19 9 19,63	1,055							
			1,022	711,74	709,74	86157,214	1,711	5,858	86164,783
	21 11,37	0,990							
			0,953	712,50	710,50	86157,473	1,488	5,901	86164,862
84	33 3,87	0,915							
83,83	Mean							Rate of the Clock	86164,755 + ,630
									86165,385

Hygrometer 14° dry.

Barometer $\left\{\begin{matrix}30,068\\30,072\end{matrix}\right.$

Mean - 30,070

	h. m. s.	°	°	"			+	+	
84,1	19 40 10	1, 19							
			1, 15	709,63	707,63	86156,492	2,167	5,985	86164,644
	51 59,63	1, 11							
			1,065	713,12	711,12	86157,684	1,858	6,028	86165,570
84,3	20 3 52,75	1, 02							
			0, 98	712, 0	710, 0	86157,303	1,574	6,104	86164,981
	15 44,75	0, 94							
			0,905	713,88	711,88	86157,942	1,342	6,209	86165,493
84,8	27 38,63	0, 87							
84,4	Mean							Rate of the Clock	86165,175 + ,630
									86165,805

April 22, P. M.

Rate of Clock + 0″,76
Hygrometer 18°,4 dry.

Barometer { 30,038 / 30,025
Mean - 30,032

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc-	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
87,6	2 9 20,37	1,24							
			1,185	708,13	706,13	86155,977	2,301	7,411	86165,689
	21 8,50	1,13							
			1,085	708,37	706,37	86156,059	1,929	7,352	86165,340
87,3	32 56,87	1,04							
			1, 00	709,63	707,63	86156,492	1,638	7,309	86165,439
	44 46,50	0,96							
			0,975	710,87	708,87	86156,917	1,558	7,288	86165,763
87,2	56 37,37	0,89							
87,37	Mean						Rate of the Clock		86165,558 + ,760
									86166,318

Barometer { 30,025 / 30,017
Mean - 30,021

	h. m. s.	°	°	″			+	+	
87,2	3 3 6,37	1,23							
			1, 17	708,25	706,25	86156,018	2,243	7,268	86165,529
	14 54,62	1,11							
			1,065	709,01	707,01	86156,279	1,858	7,246	86165,383
87,1	26 43,63	1,02							
			0, 98	710,75	708,75	86156,876	1,574	7,221	86165,671
	38 34,38	0,94							
			0,895	711,49	709,49	86157,122	1,312	7,204	86165,638
87	50 25,87	0,85							
87,1	Mean						Rate of the Clock		86165,555 + ,760
									86166,315

Hygrometer 16°,2 dry. Barometer { 29,977 / 29,977

Mean - 29,977

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
87	4 0 4, 5	1, 30							
			1, 25	707,87	705,87	86155,887	2,560	7,161	86165,608
	11 51,37	1, 20							
			1,155	708	706	86155,932	2,186	7,094	86165,212
86,7	23 39,37	1, 11							
			1,067	709,13	707,13	86156,321	1,865	7,043	86165,229
	35 28, 5	1,025							
			0,993	709,87	707,87	86156,575	1,516	7, 0	86165,091
86,5	47 18,37	0, 96							
86,73	Mean						Rate of the Clock		86165,285 + ,460
									86165,745

April 20, A. M. Barometer { 30,047 / 30,071

Rate of Clock 0",22 + } Mean - 30,059

Hygrometer 13°,4 }

	h. m. s.	°	°	"			+	+	
83,3	17 5 11, 5	1,275							
			1,233	711,37	709,37	86157,088	2,491	5,647	86165,226
	18 5 2,87	1, 19							
			1, 15	710,75	708,75	86156,876	2,167	5,689	86164,732
83,5	16 53,62	1, 11							
			1,065	712,13	710,13	86157,347	1,858	5,732	86164,937
	28 45,75	1,020							
			0,990	711,00	709,00	86156,962	1,606	5,774	86164,342
83,7	40 36,75	0, 96							
83,5	Mean						Rate of the Clock		86164,809 + 0,220
									86165,029

Barometer { 30,071 / 30,088

Mean 30,079

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
83,7	18 47 47,75	1, 36							
			1, 31	709,37	707,37	86156,403	2,812	5,829	86165,044
	59 37,12	1, 26							
			1,215	710,51	708,51	86156,794	2,418	5,888	86165,100
84	19 11 27,63	1, 17							
			1, 13	711,87	709,87	86157,259	2,092	5,956	86164,842
	23 19, 5	1, 09							
			1,043	713,25	711,25	86157,728	1,782	6,015	86165,525
84,3	35 12,75	0,995							
84,0	Mean						Rate of the Clock		86165,128 + ,022
									86165,150

Hygrometer 13°,4 dry.

Barometer { 30,088 / 30,082

Mean - 30,085

	h. m. s.	°	°	"			+	+	
84,35	19 42 26	1, 39							
			1,337	710, 0	708	86156,619	2,929	6,112	86165,660
	54 16	1,285							
			1,233	710, 5	708, 5	86156,790	2,491	6,197	86165,478
84,75	20 6 65	1,180							
			1,135	711,13	709,13	86157,006	2,111	6,281	86165,398
	17 57,63	1,090							
			1,045	713,24	711,24	86157,725	1,789	6,366	86165,880
85,15	29 50,87	1, 00							
84,75	Mean						Rate of the Clock		86165,604 + ,022
									86165,626

April 21, P. M.

Rate of Clock + 0″,37
Hygrometer 17°,3 dry.

Barometer { 30,045 / 30,038
Mean - 30,042

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
87,5	2 7 33, 5	1,275							
			1,220	708, 5	706, 5	86156,104	2,439	7,373	86165,916
	19 22	1,165							
			1,123	709,37	707,37	86156,403	2,066	7,305	86165,774
87,2	31 11,37	1,080							
			1,038	710,25	708,25	86156,705	1,765	7,254	86165,724
	43 1,62	0,995							
			0,953	711,01	709,01	86156,965	1,488	7,212	86165,665
87	54 52,63	0,910							
87,23	Mean						Rate of the Clock		86165,770 + 0,370
									86166,140

Barometer { 30,038 / 30,030
Mean - 30,034

	h. m. s.	°	°	″			+	+	
87	3 1 43,13	1, 29							
			1, 23	708,49	706,49	86155,959	2,479	7,191	86165,629
	13 31,62	1, 17							
			1,127	709,88	707,88	86156,584	2,081	7,191	86165,856
87	25 21,50	1,085							
			1,043	711, 0	709, 0	86156,962	1,782	7,183	86165,927
	37 12, 5	1, 00							
			0,955	710,88	708,88	86157,061	1,491	7,161	86165,713
86,9	49 3,38	0, 91							
86,93							Rate of the Clock		86165,781 + ,370
									86166,151

Hygrometer 17°, 5. Barometer { 30,017 / 30,007 }

Mean - 30,012

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	″			+	+	
87	3 56 31,37	1,14							
			1,085	709,88	707,88	86156,584	1,929	7,170	86165,683
	4 8 21,25	1,03							
			0, 99	711,37	709,37	86157,088	1,606	7,127	86165,821
86,8	20 12,62	0,95							
			0, 91	711,51	709,51	86157,136	1,357	7,106	86165,599
	32 4,13	0,87							
			0, 83	712,75	710,75	86157,558	1,128	7,106	86165,792
86,8	43 56,88	0,79							
86,87	Mean					Rate of the Clock			86165,724 + ,760
									86166,484

April 22, A. M.

Rate of Clock + 0″98

Hygrometer 15° dry (beginning.)

Barometer { 30,022 / 30,016 }

Mean - 30,019

	h. m. s.	°	°	″			+	+	
83,2	17 45 46	1,26							
			1, 22	714	712	86157,983	2,439	5,596	86166,018
	57 40	1,18							
			1,135	715,62	713,62	86158,531	2,110	5,617	86166,258
83,3	18 9 35,62	1,09							
			1,045	716,88	714,88	86158,955	1,789	5,626	86166,370
	21 32, 5	1, 0							
			0,965	718, 5	716, 5	86159,498	1,526	5,626	86166,650
83,3	33 31	0,93							
83,27	Mean					Rate of the Clock			86166,324 + ,980
									86167,304

Hygrometer 14°,2 dry (end.) Barometer { 30,016 / 30,040

Mean - 30,028

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
	h. m. s.	°	°	"			+	+	
83,4	18 43 3,87	1, 21							
			1, 16	715,63	713,63	86158,534	2,205	5,702	86166,441
	54 59, 5	1,111							
			1,076	717,25	715,25	86159,079	1,897	5,765	86166,741
83,7	19 6 56,75	1, 04							
			1, 00	717,75	715,75	86159,247	1,638	5,829	86166,714
	18 54, 5	0, 96							
			0, 92	718,50	716,50	86159,498	1,387	5,888	86166,773
84	30 53, 0	0, 88							
83,7	Mean						Rate of the Clock		86166,667 + ,980
									86167,647

April 23, P. M. Barometer { 30,017 / 30,008

Rate of Clock + 0",99
Hygrometer 18°,3 dry. } Mean - 30,012

	h. m. s.	°	°	"			+	+	
87,6	2 26 10,12	1,25							
			1, 20	707,50	705,50	86155,759	2,359	7,424	86165,542
	37 57,62	1,15							
			1, 10	709,76	707,76	86156,527	1,983	7,381	86165,891
87,4	49 47,38	1,05							
			1,015	709,12	707,12	86156,317	1,688	7,352	86165,357
	3 1 36, 5	0,98							
			0, 94	710, 5	708, 5	86156,790	1,448	7,326	86165,564
87,3	13 27	0,90							
87,43	Mean						Rate of the Clock		86165,588 + 0, 99
									86166,578

Hygrometer 18°,6. Barometer { 30,008 / 30,000 }

Mean - 30,004

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
°	h. m. s.	°	°	"			+	+	
87,3	3 20 31	1,21							
			1, 16	717,37	715,37	86155,714	2,205	7,297	86165,216
	32 18,37	1,11							
			1, 07	710,00	708,00	86156,619	1,876	7,254	86165,749
87,1	44 08,37	1,03							
			0, 98	709,38	707,38	86156,407	1,574	7,225	86166,143
	55 57,75	0,93							
			0,895	712,12	710,12	86157,344	1,312	7,216	86165,872
87,05	4 7 49,87	0,86							
87,15	Mean						Rate of the Clock		86165,745 + ,990
									86166,735

Table of the Results of the foregoing Experiments.

SECOND SERIES.

Day. 1821.	Time of the Experiment.	Mean Height of the Thermometer.	Mean Height of the Barometer.	Mean Height of the Hygrometer.	Number of Vibrations in 24 hours, at the temperature of 70° of Farenheit.
		°	Inch.	dry.	
April 18	A. M.	83,05	30,023		86165,857
		84,02	30,037	13,8	86165,951
		85,04	30,044		86166,032
19	P. M.	87,33	29,972		86166,442
		86,93	29,956	16,5	86166,246
		86,43	29,950		86166,382
	A. M.	83, 4	30,044		86165,639
		83,95	30,045	13,5	86165,900
		84,77	30,043		86165,970
20	P. M.	87,23	29,995		86165,473
		87, 0	29,979	17,1	86165,598
		86,73	29,977		86165,745
	A. M.	83, 5	30,059		86165,029
		84, 0	30,079	13,4	86165,150
		84,75	30,085		86165,626
21	P. M.	87,23	30,042		86166,140
		86,93	30,034	14	86166,151
		86,73	30,031		86166,179
	A. M.	83,53	30,063		86165,253
		83,83	30,065	17,4	86165,385
		84, 4	30,070		86165,805
22	P. M.	87,37	30,032		86166,318
		87, 1	30,021	17,3	86166,315
		86,87	30,012		86166,484
	A. M.	83,27	30,019	14,6	86167,304
		83, 7	30,028		86167,647
23	P. M.	87,43	30,012		86166,578
		87,15	30,004	18,4	86166,735
Mean		85,49	30,258	15,6	86166,048

The height of the pendulum above the level of the sea was 27 feet; the distance in a direct line to the sea being about 4900 yards, or 2,784 miles. The country is flat; the nearest elevation being St. Thomas's Mount, which is 9950 yards, or 5,654 miles off, and rises but little above the ordinary level.* There is a range of low hills a short distance beyond St. Thomas's Mount; and the Pulicat Mountains, which are of considerable elevation, are 39 miles off. The soil about Madras is composed of sand and blue mud, and this to as great depths as the wells have been sunk. I do not recollect any rock having been found. I have therefore used 0,66 as a multiplier to 0,095, the correction for 27 feet, which gives 0,06 to be added to the number of beats in 24 hours.

The last correction required was for the buoyancy of the atmosphere. Having no information relative to the specific gravity of the pendulum, I was obliged to determine it in the best way the limited means in this country afforded. This was done with a balance at a dispensary, and with the aid of Mr. BRUCE, the proprietor of the establishment. The Madras water drawn from wells in the Black town here, and conducted into the cisterns in the fort, is considered among the purest in the world. This was boiled, and strained into a tin trough prepared for the purpose; the pendulum also was securely and properly slung by means of brass wire, with the assistance of Mr. GORDON, jeweller, of this place. The water was at the same temperature with the atmosphere, and the experiments were made with every care. It may be unnecessary to detail them here; I shall therefore proceed to the result, which was as follows:

* About 150 feet above the level of the sea.

Thermometer 88°, barometer 30,064 inches, specific gravity of the pendulum 8,1085. Hence the specific gravity of the pendulum for the mean of the first series of observations, the thermometer being 83°,48, and barometer 30,121, was 8,02096, and the correction for the buoyancy of the atmosphere is +6,2075 vibrations. For the second series, the thermometer having been 85°, 49, and barometer 30,258 inches, this correction is 6,220 vibrations. These corrections being applied to the number of vibrations before found, will give the true number of vibrations of the pendulum in 24 hours in vacuo at the level of the sea, the thermometer being 70°, and are as follow:—

By the first series of observations, 86172,3755. By the second series, 86172,328. The mean being 86172,352.

The length of the seconds pendulum in London, (latitude 51° 31′ 8″,4 N.) at the temperature of 70°, according to Captain KATER, is 39,142213 inches. Now, the pendulum of experiment used at Madras, made 86293,44 vibrations in 24 hours in London, latitude as before, and 83 feet above the level of the sea, the mean height of the thermometer being 67°, 6, of the barometer 29,97 inches (vide Appendix). The correction for the height above the sea is 0,22, and that for the buoyancy of the atmosphere 6,566, both to be added: these corrections being applied, will give 86300,226 for the number of vibrations of the pendulum of experiment in 24 hours in vacuo at the level of the sea, the temperature being 70°. Now, $86300{,}226^2 : 86400^2 :: 39{,}142213 : 39{,}232772$ the length of the pendulum of experiment.

Then $86172{,}375^2 : 86400^2 :: 39{,}232772 : 39{,}026323087$, the length of the seconds pendulum at Madras by the first series of observations.

Also, $86172{,}328^2 : 86400^2 :: 39{,}232772 : 39{,}026280447$, the length of the seconds pendulum at Madras by the second series.

The mean of both is 39,026302 inches, being, according to Sir GEORGE SHUCKBURGH's scale, the length of the seconds pendulum by these experiments at Madras in lat. 13° 4′ 9″,1 N. at the level of the sea, in vacuo, and at a temperature of 70° of FAHRENHEIT.

Then comparing this length with 39,142213 inches, the length in latitude 51° 31′ 8,″4 N. as before stated, the diminution of gravity from the pole to the equator will be ,0052894, and the ellipticity $\frac{1}{297{,}56}$ nearly.

J. GOLDINGHAM.

Madras,
May, 1821.

APPENDIX.

The following are the Observations made by Captain KATER *in England, before the Pendulum was sent out.*

July 25, 1820, in lat. 51° 31′ 8″,4.

Clock losing 1ˢ,20 in a mean solar day. Barometer 29,83 Inches.

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°				s.	
67,4	1 5 25	1,17						
			1,70	1629			1,88	
	32 34	0,97						
			0,90	1634			1,33	
	59 48	0,84						
			0,77	1639			0,97	
	2 27 7	0,71						
			0,65	1642			0,69	
67,8	54 29	0,60						
67,6	Mean			1636	1634	86293,18	1,22	86294,40

July 26.

Clock losing 1ˢ,22. Barometer 30,01 inch.

°	h. m. s.	°	°					
66,2	1 37 28	1,28						
			1,18	1621			2,28	
	2 4 29	1,08						
			0,99	1632			1,60	
	31 41	0,91						
			0,84	1637			1,16	
	58 58	0,77						
			0,71	1646			0,83	
66,8	3 26 24	0,65						
66,5	Mean			1634	1632	86293,03	1,47	86294,50

July 27.

Clock losing 1ˢ,15. Barometer 30,01 inches.

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°				s.	
67,2	1 2 27	1,22						
			1,12	1622			2,06	
	29 29	1,02						
			0,94	1630			1,45	
	56 39	0,86						
			0,79	1633			1,02	
	2 33 52	0,73						
			0,67	1638			0,73	
67,8	51 10	0,62						
67,5	Mean			1630,75	1628,75	86292,89	1,32	86294,21

July 28.

Clock losing 1,05. Barometer 30,01 inches.

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°					
67,8	0 50 41	1,19						
			1,09	1614			1,95	
	1 17 35	1,00						
			0,92	1624			1,39	
	44 39	0,84						
			0,78	1630			1,00	
	2 11 49	0,73						
			0,67	1627			0,73	
68,4	38 56	0,62						
68,1	Mean			1623,75	1621,75	86292,53	1,27	86293,80

July 29.

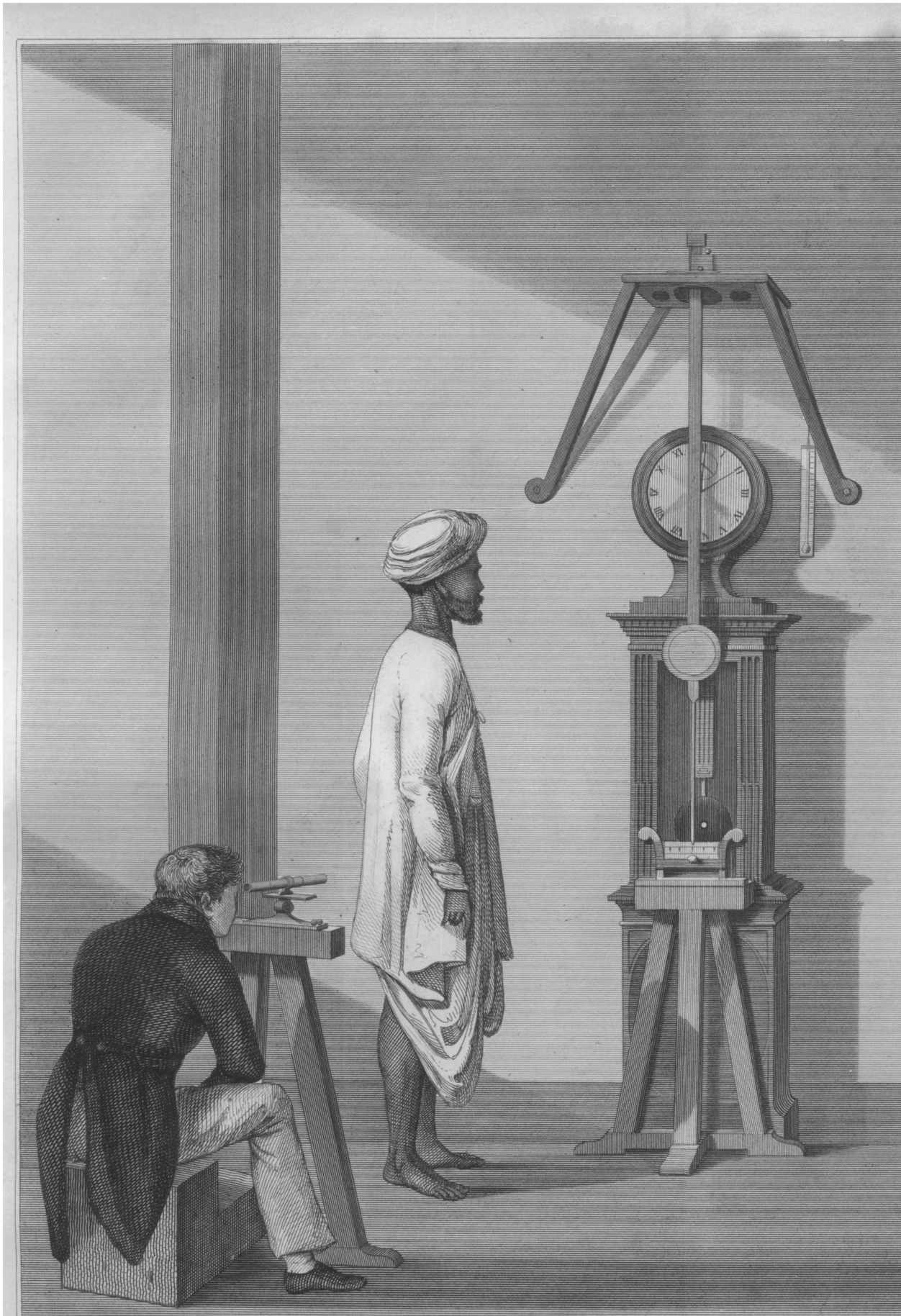
Clock losing 1ˢ,07. Barometer 30,01 inches.

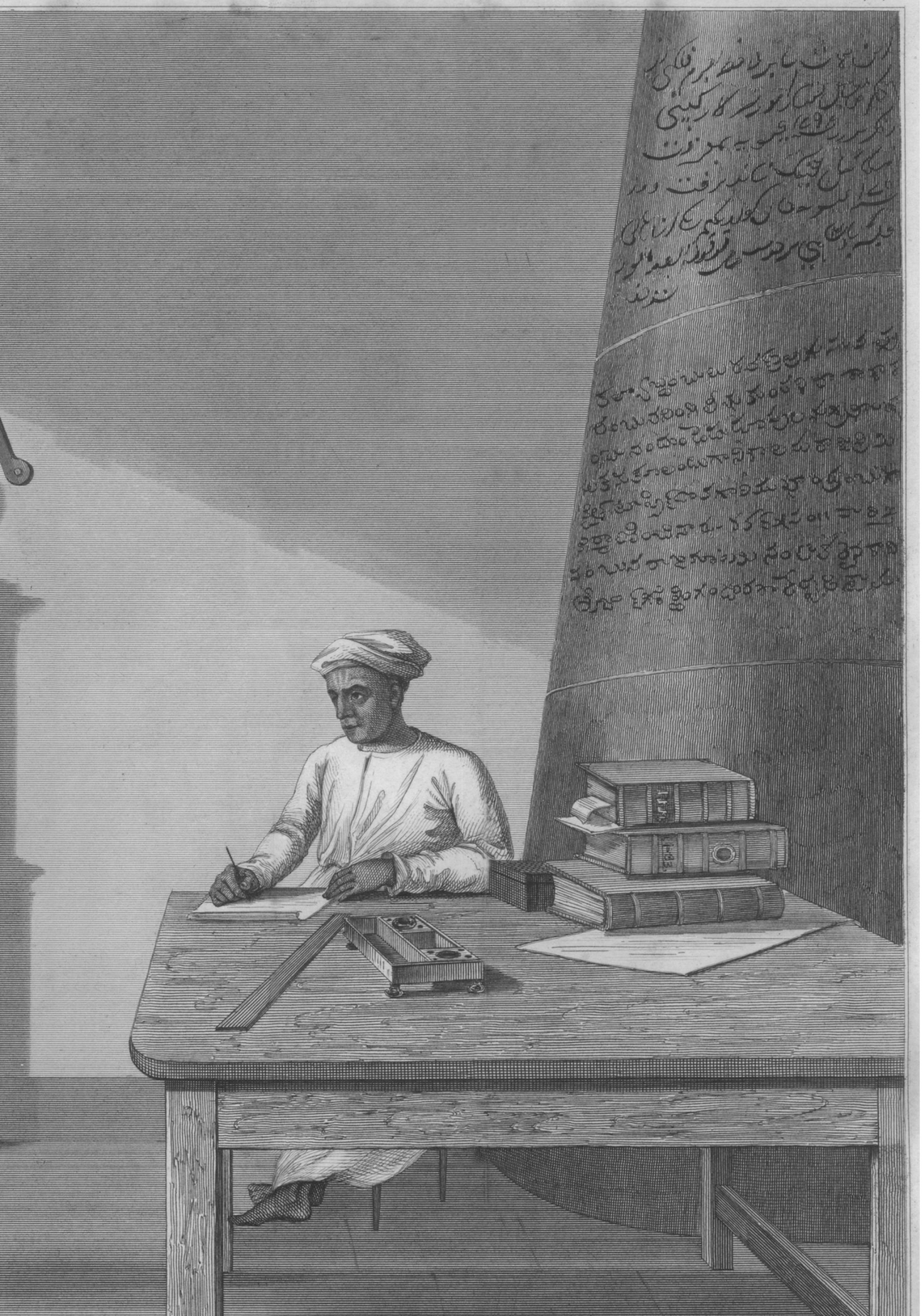
Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°					
67,9	0 47 1	1,21						
			1,11	1616			2,02	
	1 13 57	1,02						
			0,94	1620			1,45	
	40 57	0,86						
			0,79	1625			1,03	
	2 8 2	0,73						
			0,68	1630			0,76	
68,8	35 12	0,63						
68,3	Mean			1622,75	1620,75	86292,45	1,31	86293,76

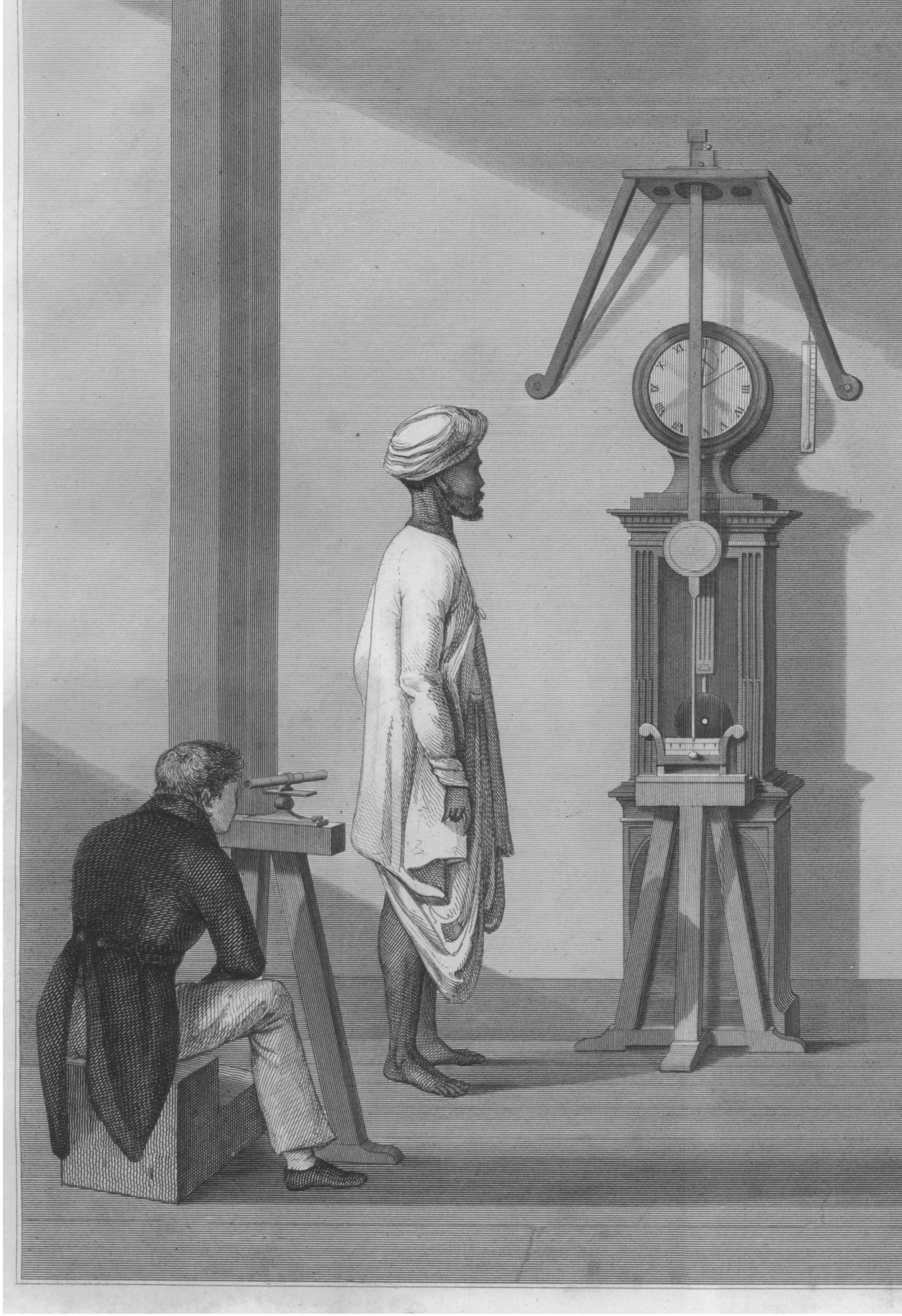
Vibrations of the Pendulum at London.					
Date 1820.	Barometer.	Thermometer.	Vibrations in 24 hours.	Correction for Temperature.	Correct vibrations in a mean solar day at 70°
	Inch.	°			
July 25	29,83	67,6	86294,40	1,02	86293,38
26	30,01	66,5	86294,50	1,48	86293,02
27	30,01	67,5	86294,21	1,06	86293,15
28	30,01	68,1	86293,80	0,70	86293,10
29	30,01	68,3	86293,76	0,72	86293,04
Mean	29,97	67,6			86293,14

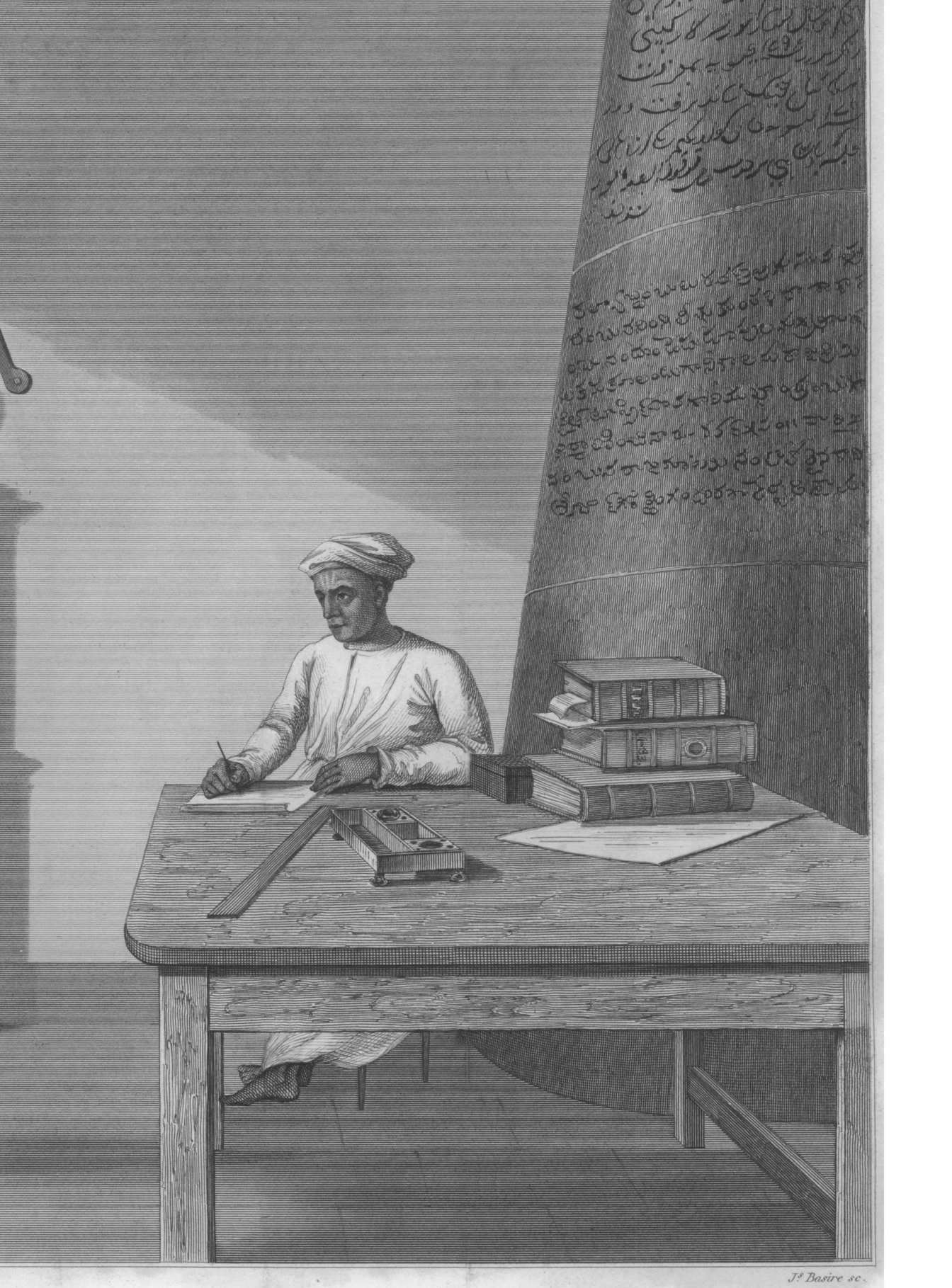
From the above table it appears, that the pendulum makes 86293,14 vibrations in a mean solar day, in latitude 51° 31′ 8″,4 the temperature being 70°, and the height above the level of the sea 83 feet. The correction employed for temperature is 0,423 of a vibration for one degree. In computing the correction for the buoyancy of the atmosphere during the experiments, the temperature of 67°,6 must be used, the barometer being at 29,97 inches.

J. GOLDINGHAM.









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